that the thought shall precede the form, that the symbol shall not conceal the thing symbolised. They insist that systematic and progressive problems based upon every-day experience and observation shall be, to a much greater extent, the materials of education. They demand that the several elementary mathematical subjects, from arithmetic to the calculus, shall develop side by side in the boy's mind. They demand that the mastery of these subjects shall be more the work of the judgment than of the memory. They demand that from first to last, at least during the secondary period, mathematical ability and the ability to think clearly, investigate closely and conclude correctly shall develop together, and to the extent that four well-spent years will on the average permit. Those who formulate these ideas contend that they lead to the correct mathematical training for all professions and all careers.

The proposition that mathematics is the very bone and sinew of an engineering course needs no discussion. It is everywhere conceded. The extent and nature of the mathematical element in the curriculum, however, are two decided fluents with curves of opposite slope. More mathematics but fewer kinds seems to be the tendency. The opinion appears to be gaining ground that the purely descriptive and highly specialised and professionalised elements in our technical courses should be reduced, while more subjects with a mathematical basis, with long unbroken continuity and bound together with a strong logical element should command the attention of the student to the end of his undergraduate period.

Upon the question as to what mathematical subjects shall the undergraduate courses include in our technical colleges, opinions are decidedly at variance. Upon the four ordinary elementary subjects the sentiment is practically unanimous, but these should be principally taught in the secondary schools. The practical people, however, are inclined to relegate analytic geometry and the calculus to the scrap pile. To such subjects as vectors, theory of functions, theory of groups, they allow no place whatever.

One cannot but feel that this verdict against analytic geometry and the elementary calculus—not to mention higher subjects—is a great pity. Especially does it seem true when we recall that instruction in these two lines forms the principal mathematical element of the second and third years of the ordinary technical course, and that the calculus itself is probably the most powerful and wonderful tool for investigation that the genius of man has ever contrived.

Why do practical men almost unanimously place calculus among the dispensable elements of a technical curriculum? The answer, of course, is very simple; they have never found any use for it, probably because they have never learned how to use it. Yet they dare not pronounce against it altogether. They know that Rankine and Maxwell were master mathematicians, and that through this mastery of the most powerful of tools they were able to do for terrestrial what Newton and Laplace did for celestial mechanics. In college the engineer has not learned to use the modern tool called the higher analysis; it remains to him as foreign currency. Out of college he has not time to learn its use.

The most effective teaching of the higher analysis will be possible only when reforms in mathematical instruction have permeated the principal secondary schools.

The teacher should be saturated with his subject. Not only should he be strong and apt on the formal side, but more important still, its inner meaning should be clear to him and its close relation to the phenomena of the objective and subjective life. Some contend that the only man to whom the mathematics of a technical college can be entrusted is an engineer. Does that make any difference? Rather are not these the essential questions? Does the man know his subject? In his teaching can he assemble from engineering and other records the material that will vitalise his work? Is he in sympathy with engineering essentials and ideals?

Throughout the college course the teaching should be mainly concrete. The problem, say from the physical sciences including engineering, should first be presented concretely. It should then be stated in mathematical symbols. The operations performed upon the symbols should be accompanied by drawings or models, the final result reduced to numerical form, and then interpreted in language. Upon every problem the student must bring to bear the whole range of his acquired powers and be taught to select the shortest method within his ability.

In other words, all typical problems should receive a threefold consideraton :—(*a*) its statement in words, and the statement in words of its solution when effected; (*b*) its graphical statement and solution, involving geometry and mechanical drawing with squared paper; (*c*) its analytic statement and solution, ending with a numerical result.

The purely formal should be presented as a necessity arising from the so-called practical, and in order that a body of knowledge and technical ability may be accumulated which will give the student easy control over the practical in whatever one of its various forms experience shows that it may arise.

The problems chosen should be progressive in character, and their mastery should amount to a complete laboratory course in all that part of the higher analysis in which it is desirable that the engineering student should be well versed.

The course should be lecture and seminarium and individual, more after the manner of the German Technische Hochschule. The text-book should become a book of reference. The instructor should know clearly and be able to state accurately the limitations of his methods, but abstruse discussions of obscure points should be postponed as long as a due regard for logical development will allow. Time is wasted in removing difficulties the existence and importance of which the student has not yet recognised.

These are some of the necessary extensions into college work of the reformation now urged upon the secondary schools, and though every one of them seems familiar enough when taken separately, all together their united application to the mathematical courses in our technical colleges amounts to a departure from our present traditional methods little short of revolutionary.

In recent years mathematical instruction in the United States has greatly improved in its thought content, but it has responded slowly and conservatively to modern methods. We are still more English than German. In the work of training a master of the physical sciences the text-book and the senseless repetition of words and formulas have been replaced by the lecture, the laboratory and the seminarium. Why should not mathematics, so intimately related to them, follow their lead and partake in the benefits of modern methods carried to their legitimate and logical completion?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

HARVARD UNIVERSITY has, we learn from *Science*, received a gift of 50,000*l.* from Mr. David Sears, of Boston, a graduate of the class of 1847.

A COMMEMORATION day will be celebrated at Glasgow University on April 19, when an oration will be given by Sir William Ramsay on Joseph Black, who was lecturer on chemistry from 1756 to 1766 in the old college.

DR. HAROLD JACOBY, adjunct professor of astronomy at Columbia University, New York, has been promoted to a professorship. Prof. Jacoby will continue as acting director of the Columbia University Observatory during the absence of Prof. Rees on account of illness. Dr. C. L. Poor, formerly at the Johns Hopkins University, has also been appointed a professor of astronomy, and will be associated with Prof. Jacoby at Columbia.

THE governing body of the South-western Polytechnic, Chelsea, has unanimously appointed Mr. Sidney Skinner, of Christ's College, Cambridge, to the position of principal in succession to Mr. Herbert Tomlinson, F.R.S., who is retiring. Since 1888 Mr. Skinner has been attached to the teaching staff of the Cavendish Laboratory at Cambridge, and also has acted as lecturer and director of natural science studies at Clare College. Mr. Skinner will take up his duties at the polytechnic about the beginning of May next.

LORD CURZON'S scheme for the reform of Indian education, referred to last week (p. 476), has been received with approval in this country, especially in so far as it condemns the dominating influence of the examination system. The whole system of education is to be reorganised with the idea of coordinating all the forces and promoting action in rational directions. A Reuter message from Calcutta states that on Monday, March 21, the Universities Bill was passed by the Legislative Council after a second sitting lasting three days. In the course of a speech upon the objects of the Bill, Lord Curzon said that the university question was a most vital, tremendous, and sacred one, and would have a profound effect upon the future of the people.

A FREE public reference library, having distinctive characteristics, is in course of formation by the London County Council at the Horniman Museum, Forest Hill. The primary intention is to encourage the study of geology and the biological sciences—especially as represented in the Horniman Museum collections—by providing the best books on these subjects, more particularly the works of admitted authority which, by reason of cost and a relatively small demand, are not ordinarily found in libraries freely accessible to the general public.

IT has already been announced that the Committee of the Privy Council has agreed to recommend the scheme for the foundation of the University of Leeds on the understanding that a capital sum of at least 100,000*l.* be raised for university purposes. At a meeting of Leeds citizens held on Tuesday, it was stated that annual grants amounting to about 12,000*l.* have been promised from various public sources, but the power to utilise this additional income effectively will depend to a great extent on the raising of a sufficient capital sum to carry out the extensions. These extensions, with their equipment, will cost not less than 70,000*l.*, and an effort should be made to add at least 50,000*l.* to the endowment fund. Promises of nearly 40,000*l.* have been already received. Many of these are, however, conditional on 100,000*l.* at least being raised. The following resolution was unanimously adopted:—"That this meeting welcomes the foundation of a university upon the basis of the Yorkshire College, and expresses its earnest hope that such a capital sum will be obtained forthwith as will enable the university to carry out the important educational purposes for which it will be established."

IN a lecture delivered at Owens College, Manchester, on March 15, Mr. Brudenell Carter laid down the general proposition that if ever the art of education is placed upon a scientific basis, it will properly be regarded as a department of applied physiology. Referring to the educators of to-day, Mr. Carter said that their art is purely empirical, and they work upon a basis of limited personal experience uncontrolled by scientific knowledge or by any general and admitted principles of action. They differ widely from one another on questions which should be placed beyond the reach of doubt, and there is no general recognition of any authority to which they can appeal. In these circumstances it is surely time for physiology to emerge from her seclusion and to apply herself to a systematic investigation into that which is fitting or necessary to be done. The physiologist who desires to elucidate educational problems, the lecturer remarked, is confronted by three of primary importance. The first is to ascertain the conditions which determine the greater or less strength of the brain as a whole; the second, assuming every healthy child to be adequately furnished at birth with brain cells in a rudimentary state, is to ascertain what are the conditions which call those cells into activity or which condemn them to remain only partially developed; and the third is to ascertain what circumstances determine development in one direction rather than in another.

THE Goldsmiths' Company has decided to give up the Goldsmiths' Institute at New Cross on September 29 next, and the staff have received notice that their engagements will be terminated on that date. The reasons for this decision of the company are given in a letter addressed to all members of the staff. The letter states that the funds necessary for the site, buildings, equipment, and maintenance of the institute have been provided out of the company's private resources, and as a consequence the institute has, unlike the other polytechnic institutions in the metropolis, occupied an entirely independent position; but this independence cannot be maintained in the future, for the Education Act has constituted a single authority for the whole of London education, and this body will have supreme power over all schools and institutions maintained by public money. It is desirable that voluntary institutions such as the Goldsmiths' Institute should be coordinated with other metropolitan educational institutions. It has of late been increasingly difficult for the Goldsmiths' Institute to hold its own, and to keep pace with other institutions financed by means of charitable and public funds, and this difficulty will be greatly accentuated in the future, having regard to the fact that the cost of secondary, as well as that of primary, education will be paid for out of the rates. For these and similar reasons the Company has decided to discontinue the institute.

SIR DONALD CURRIE has given 80,000*l.* for the erection of a school of advanced medical studies in connection with University College, and in this way has removed the only impediment to the complete incorporation of University College with the University of London. In a letter to Lord Rosebery, the Chancellor of London University, and Lord Reay, president of University College, making known his generous intention, Sir Donald Currie says he gives the sum necessary for the purpose knowing that when the incorporation has been accomplished, University College "will be maintained as a centre of wide academic culture, and that anatomy, physiology (including pharmacology), biology, chemistry, physics, &c., which are subjects of preliminary and intermediate medical study, will still continue to be taught there." In addition, Sir Donald Currie has given a further 20,000*l.* to provide a suitable nurses' home and accommodation for medical students, and his daughters have given 2500*l.* to furnish the home and to secure a library for it. In thanking Sir Donald Currie for his magnificent gift, Lord Rosebery and Lord Reay point out that the donation will assist the university and the college to carry out the scheme of incorporation which it is believed will be of the highest importance to the future of university education in London, and will direct the course of the university authorities along the line of development by which London may be made the seat of a university worthy of the metropolis of the Empire.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 3.—"The Optical Properties of Vitreous Silica." By J. W. **Gifford** and W. A. **Shenstone**, F.R.S.

The authors have made a number of measurements of the optical constants of vitreous silica, which substance, owing to its uniformity of composition, to its great transparency to ultra-violet radiations, and to its not being doubly refracting like quartz, seems likely before long to play an important part in optical work.

At present it is rather costly, but this difficulty is rapidly being overcome.

The prisms used by the authors were made by processes already described in our columns (NATURE, vol. lxii. p. 20, and vol. lxiv. p. 45). The uniformity of the new glass was tested by building up a compound prism from four slabs of silica, prepared separately, by cementing them one above another and then cutting a prism from the mass. This was compared with a similar prism made from four pieces of borosilicate glass (Schott's No. 0·364), all from the same melting, and was found to be distinctly superior in its performance to the latter.

The paper includes a curve for a thin doublet of fluorite achromatised with vitreous silica which shows that the focal length of the combination is almost independent of the wave-length, also a list of focal lengths for a lens of fluorite and vitreous silica, and a table of the partial and proportional dispersions of fluorite, vitreous silica and quartz.